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ABSTRACT

The monograph reports on two surveys conducted by the Open University (United Kingdom) to evaluate the likely consequences of the university's new home computing policy (which requires access to a microcomputer for certain courses) on students with disabilities. A telephone survey was taken of 23 disabled students, and questionnaires were completed by 16 disabled students. Results are reported in terms of student course selection, problems with computing courses, equipment reliability, financing a home computer, documentation and training, and special equipment. Major conclusions included the following: it is imperative that alternatives be made available to students who cannot afford to buy a computer; for many disadvantaged students, the home computing policy will improve their educational opportunities; disabled students will generally experience the same problems as other students under the home computing policy; there is a small number of disabled students whose disabilities make access to computers very difficult and who may be penalized by the home computing policy. Appended are a summary of the home computing policy and the questionnaire used in the survey. (Four references.) (DB)

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The use of home computers by disabled students at the Open University

Part 1:

Previous use of computers in courses

A D N Edwards

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The use of home computers by disabled students at the Open University

Part 1:
Previous use of computers in courses

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4th January 1988

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Abstract

The Open University is in the process of implementing a policy whereby students on certain courses will be obliged to have access to a microcomputer. Previously computing had generally been carried out on the university's mainframe computers, accessed through terminals in local study centres. The effects of the Home Computing policy will be far-reaching and amongst the students who will be particularly affected are those who have disabilities. In order to anticipate some of the likely consequences of the policy for disabled students two surveys were carried out amongst disabled Open University students. One survey concentrated on students who had taken courses in the past which had involved the use of computers. The second included students who had used computers as aids to their studying. This paper reports the results of the surveys.

The results suggest that the Home Computing policy will represent an improvement in the position of disabled students; it implies that they will be able to work with greater independence from their own homes. There are a number of problems, however. The two most important are: the need for support at a number of different levels in the provision and maintenance of equipment, and the financial consideration for students taking Home Computing courses. This is especially important to the many disabled students who are on low incomes.

1. Introduction and background

This report presents the result of two surveys of a number of Open University (OU) students who have disabilities. The objective was to identify the likely effect of a new policy of the university, whereby students taking certain courses will be obliged to have access to a microcomputer.

The Open University is a distance learning institution. From its inception it has had special concern for the education of people who have disabilities, and this is in fact enshrined in the university's Charter. Distance learning has a lot of advantages for many people who are disabled. One is that they can work at home and thus avoid the mobility problems they might incur in attending a conventional university. The university provides a wide range of special facilities to help students who are disabled to overcome disadvantages which might affect their study. In fact the Open University now has around 3000 students who are classed as disabled, which is more than all the other British universities added together.

In 1987 the university adopted a policy, to come into effect at the beginning of the following year, whereby the use of a microcomputer would be a major and compulsory component of selected courses. Prior to 1988 some courses had contained a practical computing element. Generally, however, this was not a major part of the course and students usually did not have to use a computer at home. For most of these courses students accessed university mainframe computers through terminals in local study centres or at Summer Schools. Where students had access to the appropriate equipment (a suitable terminal and a modem), they were allowed to use them to dial into the university's computers instead of using study centres. However the university's Academic Computing Service (ACS) was only able to offer a minimal level of support to such students to help them set up the appropriate links.

Science courses in the university often involve practical work by the student at home. The equipment required is *loaned* to the students for the duration of the course in the form of a *Home Experiment Kit*. Some computing courses have involved the use of a home microcomputer which was loaned in the same way. Several of these courses used the *Hektor* - a microcomputer which was developed within the university specifically for

the purpose. As a very inexpensive machine, it was possible for it to be loaned to students. For the course *The Digital Computer* (TM222) the Hektor was specially modified so that it gave synthetic speech output, so making the course accessible to visually disabled students. Some other courses used a different inexpensive loaned microcomputer.

EH221, a course on *Educational Computing*, also involves the use of a microcomputer. In this case it is the BBC Model B. This machine was chosen since the course was aimed primarily at school teachers, and the computer is one which widely available in schools. Similarly two other courses aimed at teachers expected them to have access to one of a number of the microcomputers commonly found in schools.

The inception of the Home Computing policy meant that students would do the majority of their practical computing work on a microcomputer and not on the university's mainframes. This implies that students need to use powerful, modern microcomputers, which are not cheap and which could therefore no longer be supplied, without charge, as part of the course. This policy was adopted "because it is no longer practical to support the requirements of computer science and some other courses through study centre based facilities." (See Appendix A).

Adoption of the policy had a number of significant implications and raised several questions. One question was who was going to pay for the computers. Another was which computer or family of computers should be adopted. As well as the hardware, choices had to be made about the software which would be used. These are all difficult questions, which could only be resolved by consultation between the wide number of interested parties.

Among the people who will be affected by these decisions are students with disabilities. In order to cater for some of the particular requirements of these students arrangements have been made to ensure that they will be given support in the provision of equipment and training. The university has established a pilot project for the first year of the Home Computing policy, with the National Federation of Access Centres. Through this arrangement students will receive a formal assessment of their requirements and any special adaptations and training required will be supplied.

However, it is difficult to predict what the full implications of the adoption of the policy will be. The purpose of this report is to try to illuminate some of the likely implications for students who are disabled. The approach adopted is to learn as much as possible from past experience.

This paper forms the first part of a two-part report. This paper looks back to the lessons which can be learned from the past use of computers by disabled Open University students. The second paper will make recommendations about how these lessons might be applied in the future design of courses and course software.

2. The Surveys

As mentioned above, Open University courses in the past have included the use of computers, so it is possible to study the effects they have had on the education of students with disabilities. Computers are also used by some people who are disabled as aids to their studying. For the most part this implies the use the computer as a word processor by people who cannot write manually. A large number of Open University students use computers in this way, and represented another group whose experience is valuable to this project.

Many forms of disability are likely to affect a person's ability to use a computer. Computers generally display output information on a screen and require input from the user via a keyboard and/or a pointing device, such as a *mouse*. So, broadly, disorders of vision and those which affect manual dexterity are likely to have the most serious detrimental effect on a person's ability to use a computer. Currently most computers make minimal use of auditory output, so that hearing disabilities are less likely to cause problems. Other forms of disability which affect a person's mobility may have an indirect effect on their ability to use computers; as will be shown below, some people can use a computer only if it is located in their home.

The aim of this project was to get a rapid impression of the likely impact of the Home Computing Policy on disabled students. Speed was important because the policy was being adopted soon, coming into effect in January 1988. It was therefore decided to survey a relatively small number of students rather than taking the time to carry out a more

comprehensive study. It was not intended that the surveys should have any statistical significance.

Within the population of disabled students there were three groups of particular interest: those who had taken courses which involved the use of computers, those who had not and those who have used computers as a study aid. The experience of the former group would be an invaluable guide to the needs of such students, while the latter group was included in order to see whether the need to use computers deters some people from taking particular courses.

Two sources of subjects were used: students selected from lists of those taking courses which used computers as described above, and those who responded to a questionnaire published in a newsletter distributed to all disabled students by the university's Office for Students with Disabilities.

Two related surveys were carried out. The first one was intended to get information regarding disabled students taking computing courses. To that end the survey was aimed at students who were selected according to the courses they had - or had not - taken. There was no deliberate selection of subjects for the second survey. This took the form of a questionnaire which was sent to all Open University students who are disabled.

Because the results of the two surveys differ in their significance they are presented separately below, in Sections 3 and 4. The implications of those results, and the connections between them are then brought together in Section 5.

3. Results of the telephone survey

In all of the university's faculties except Arts there are number of courses which involve some use of computers. For the purposes of this survey it was decided to concentrate on the following ones:

D309	*Cognitive Psychology*
EH221	*Educational Computing*
M352	*Computer-based Information Systems*
M353	*Programming and Programming Languages*
TM222	*The Digital Computer*

However, it was found that a number of the students surveyed had taken other courses involving some use of computers. (See Table 1).

For this first survey lists were obtained from the Office for Students with Disabilities of disabled students who had taken the above courses. From those lists, students were selected whose disabilities seemed likely to have affected their ability to use computers.

One objective of this project was to ascertain whether students who are disabled might avoid taking courses involving computers because they anticipate access difficulties with the equipment. To that end an attempt was made to identify students who might have done this in the past. So students were selected who had taken courses in the faculties which offer courses with a computing element (i.e. all the faculties except Arts). If students who had taken only arts courses were surveyed it would be easy to find a large number who had taken no computing courses, but it would have been less likely that they had avoided computers for practical reasons; they may simply find arts courses more interesting.

In fact it proved quite hard to find students in this way who had done no computing at all, mainly because so many maths, science and technology courses do include some computing. For instance, the maths foundation course, M101, does include a small computing element. Since all degree students must take foundation courses from two faculties, a large proportion of the students of interest will have taken M101, and hence done some computing. In fact just three students in the final group surveyed had done no computing courses at all. The characteristics of all of the students surveyed in this phase of the project are summarized in Table 1.

As far as possible, this survey was based on telephone conversations with the students. They were firstly contacted by letter, by way of introduction. (Visually disabled students were sent a print letter, accompanied by a cassette tape). This was followed up by a telephone call in which the student was interviewed on the basis of a questionnaire (see Appendix B). Some students could not be interviewed by phone, for the following reasons: they did not have a telephone; they had a hearing impairment which precluded their using the telephone or they could not be contacted on the number recorded for them. In all these cases the students were sent a printed questionnaire as an alternative.

Subject	Nature of disability	Use of computers other than on OU computing courses	OU computing courses taken	Sex
1	Partially hearing	none	M101, S101, TM222	F
2	Brain damage	none	M101, M252, MST204	M
3	Blind	none	M101, M203, M252, MST204	M
4	Restricted manual dexterity	none	M101, M252	M
5	Limited manual dexterity	none	M252 , TM222	M
6	Spasticity in hands	Uses a BBC computer for TMAs, and amusement.	TM222	M
7		(Questionnaire not returned)		
8	Rheumatoid arthritis, limited manual dexterity	none	TM222[1]	F
9	Quadraplegic, unable to use fingers	none	M252	M
10	Muscular dystrophy	Learned to program in Basic at college.	M252	M
11	Partially hearing, limited manual dexterity	none	M252, TM222	F
12	Partially sighted	Uses screen-based design aids in his job as systems analyst.	M101, M252, MST204, T101	M
13	Multiple scleroris	none	M252, M352, TM222	F
14	Limited manual dexterity	Works as systems analyst in Civil Service.	M352, M353, T283, TM221[2]	M
15	Spinal injury	Word processing Basic programming.	M252, M352	M
16	Tetraplegic	none	M252	M
17	Partially sighted	Word processing. Owns "3 or 4" computers.	M353	M
18	Loss of left arm, right arm paralysed	Word processing on an Amstrad (Uses mouth stick).	**NONE**	M
19		(Questionnaire not returned)		
20	Multiple scleroris, blurred vision, cannot write for long periods	Took course on Cobol programmning. "Not very successful".	EH221	F
21	Blind, diabetes	none	**NONE**	F
22	Blind		**NONE**	F
23		(Questionnaire not returned)		
24	Blind	Works as a programmer	M101	M
25	Angina, arthritis (finds writing tiring)	none	EH221, M101 PME233, TM222	M
26	Partially sighted	none	D303[3]	F

[1] This student registered for the course for 1987, received the Hektor but not other material. She plans to attempt to re-register for 1988.

[2] TM221 was a course which was succeeded by TM222.

[3] D303 was a course which was succeeded by D309.

Table 1. A brief description of the students surveyed by telephone.

This part of the survey is referred to here as the telephone survey. Although as just explained this is not strictly accurate (since students who could not be contacted by telephone were sent questionnaires), it will serve to distinguish this part of the survey from that based on a questionnaire distributed to all disabled students, as described in Section 4.

3.1 Selection of courses

Twenty six students were contacted and responses were obtained from twenty three of them. All the students had made a conscious decision either to take course involving computers or to avoid them. Many of those who chose to take them did so in the hope of improving their employment prospects. Some of them saw computer-related jobs as something they could undertake despite their disability. Often those people had no previous experience of using computers. By contrast, others who chose to take computing courses had extensive experience of computing since they worked in computer-related jobs. Taking Open University courses is to them another means of pursuing an interest.

Of the (three) students who had avoided computer courses completely, only one said she had done so because she thought her disability (blindness) would make it too difficult to do the course. The other students who had avoided computing courses had done so for the same sort of reasons that anyone might: that computers just do not appeal to them. One such student had become disabled following an accident. As part of a rehabilitation course, looking for potential sources of new employment, he had taken a computer aptitude test. He had not scored well on this test, and had hence discounted using computers in employment.

Other students had avoided computing courses indirectly. One avoided courses with Summer Schools and another would only take courses which she could study entirely from home. She would not go to a study centre. Thus, she effectively excluded most computing courses.

All but two of the students said they would consider taking a Home Computing course. The two who did not were both people who had avoided computing courses in the past. Most of the others (eleven of them) said they would definitely consider taking such a course, but some of them did have reservations. Their concerns included finance, the

provision of special equipment (i.e. a blind student who would need speech output) and the availability of modified material. One student said it would depend on how badly he wanted to do the course.

Several of the students indicated that they would be more willing to take a Home Computing course than some of the old study-centre-based ones. This accords with the attraction of distance learning in general to people with disabilities. As mentioned earlier, many people with disabilities choose to study with the Open University because they can study without the mobility problems they would encounter in a conventional university. For them, the need to use terminals in a study centre re-introduces some of those mobility problems and they would be much happier using a computer at home.

3.2 Problems with computing courses

One of the commonest complaints about equipment on computing courses was no longer applicable since it referred to old hardware not used any more. This was the old teletype-style, electro-mechanical terminal which was used in the past. Some students had difficulty using the keyboard on these older machines as the keys have to be pressed quite heavily. Others, who have visual impairments found it harder to read the output, which was printed on paper, than text displayed on a cathode ray screen. Although this specific problem no longer exists, it does illustrate the sort of unnecessary difficulty which can be caused if the needs of students with disabilities are not taken into account in the provision of equipment.

There were other problems of reading computer output. One student has to use different spectacles to read from a screen from those he needs to read from a text book. This can involve a lot of swapping of spectacles in the practical sessions!

Another student said he had been unable to read output on a screen because it had been displayed too quickly, and 'scrolled' out of view, off the top of the screen, before he could read it. The unfortunate aspect of this problem is that a remedy is available - it is possible to 'freeze' the scrolling text by pressing the appropriate keys - but this student had no means of finding out how to do that. Such problems may occur more frequently when students are working with computers in even greater isolation in their own homes.

It was suggested by one of the students that people with visual impairments would be aided by the availability of larger screens of better quality.

Many of the students surveyed had other problems using keyboards. In fact three of them identified the slowness of their typing as putting them at a significant disadvantage compared to other students on the courses. One student suggested that on study-centre-based computing courses a concession should be made to disabled students that they should be allowed to book longer terminal sessions.

One student found that the keys on his BBC computer (he is taking EH221) 'auto-repeat' too easily.[1] Auto-repeating can cause problems for people of limited manual dexterity who may not be able to remove their finger from a key quickly. This can mean that when they are trying to press a key to get just one letter, they end up with more than one printed.

Another student has spasticity of the hands which is so severe that he has problems pressing the correct keys. In fact, he has resorted to getting someone else to do his typing for him.

One other student was able to use only one hand for typing. On most computer keyboards this is not sufficient since it is frequently necessary to type combinations of keys. For example, to type an upper-case letter the typist generally holds down a *shift* key, and at the same time presses the appropriate letter key. On most typewriters there is also a *shift lock* key which remains depressed when pushed once, so that all letters typed thereafter will be upper case. The lock can then be released by another press. Some computer keyboards do not have shift locks as such. There is a corresponding key (sometimes called the *caps lock*), but its 'shifting' affects only the alphabetical keys; to type a symbol which shares a numeric key, the shift key *must* be used. For example, the left bracket '(', is usually *shift-9*, pressing the *9* key while the caps lock is on will print a *9*, not a bracket. Furthermore, computers often require the inputting of special characters, known as *control* characters. These are typed by holding down a *control* key and pressing the appropriate letter, in the

[1] Auto-repeating is a feature of keyboards whereby if a key is held down for longer than a set delay, then instead of a single copy of the corresponding letter being typed, a number of copies of it appear. In fact, the letter will keep appearing until the key is released again.

same manner as the shift key is used. However there is no corresponding 'control lock' key on any unadapted keyboards. The student who was able to use but one hand coped by using that hand in combination with a mouth stick.

One problem encountered by users of the Hektor was that it could not be attached to a domestic television instead of a computer monitor. This was a particular problem for one of the students surveyed because she could read text better on a television screen. In fact, with the assistance of a technically able friend she was able to have her Hektor modified in quite a simple manner, so that it could be used with a television.

As mentioned above, some students with disabilities found computing courses more difficult than those which they can study entirely at home, because they incur mobility problems in attending study centres. One physically disabled student had difficulty getting to the study centre, and once there found the chairs unsuitable for his use. He therefore instituted his own 'home computing policy' and obtained software so that he could do the course on his home microcomputer. As well as having to obtain the software, he had a considerable amount of extra work to do in that he had to create his own copies of computer files for the course. To do this he obtained printed listings of the files from the study centre, and then typed them into his home computer. This is a formidable extra burden. A similar point was raised by another student with regard to the course S101 (the Science Foundation course). A tutor on that course had transferred files from the university computer onto microcomputer floppy discs. He was willing to give students copies, but this was entirely his own initiative and nothing to do with ACS. It was therefore very difficult for students to get copies, and so transfer their computing work to their home computers. None of this will be necessary on future Home Computing courses, where all the computer material will be distributed as a matter of course.

3.3 Equipment reliability

One likely source of problems for students on Home Computing courses is dealing with break-downs of the equipment. Students surveyed were therefore asked about their experiences of reliability problems.

Most of them had had very few if any problems. Only one of them had been deprived of equipment for a long period while it was being repaired.

Break-downs could lead to wasted time. Possibly the most frustrating example was of students taking the trouble to get to a study centre, only to find that the terminal which they had booked was out-of-order and hence unavailable. Once again this is a phenomenon which will be a thing of the past on Home Computing courses.

3.4 Finance

One aspect of the Home Computing policy which naturally concerned students was how a home computer would be financed. Many of the students were not in employment and were dependent on social security benefits for their income. This is sometimes supplemented by charities for special requirements, such as computing equipment for their Open University studies. Most of the students said they would consider borrowing a computer if they wanted to to a Home Computing course. One said he definitely would not buy a computer - even at a discounted rate - since it would become obsolete too quickly to be worth-while. Another said she would be reluctant to buy a computer initially, but would consider borrowing one on a 'sale-or-return' basis.

3.5 Documentation and training

Most of the students surveyed seemed quite happy with the documentation they had used. Two people particularly praised the Hektor manual. One student also complemented the manual *Using the OU Computer*. There was one complaint about the *Logo Manual*. Another student suggested that there was a need for a manual on how to use the computer terminal.

Students were also asked whether they felt they would have benefited from an introductory course on the use of computers *before* they commenced the course work. Responses were mixed. Four said they would have liked to have taken such a course, five said they would not.

Those who were in favour of such a course suggested that it could be at quite a basic level. One suggested that such a course could be made a part of *Preparing for a Foundation Course*.

One of the students felt that the computing element in the Mathematics foundation course, M101, amounted to an introductory computer course. However, another pointed out a problem with the Home Computing Policy. The proposed Technology foundation course, T102, will be a

Home Computing course. It will take the role of an introduction to computing for many students, but there may be others who do not take T102, but take foundation courses in other faculties, and whose first exposure to computers will be in a second- or third-level course.

Those who did not think an introductory course would have helped them were mostly those who had prior experience of using computers before they started computing courses in the university.

3.6 Special Equipment

Some of the students surveyed were using a variety of adaptations to enable them to access the equipment. (The university's Office for Students with Disabilities has carried out a much broader survey into equipment use by students, see Open University, 1987).

One visually disabled student was using a magnifier to see the computer screen, and used a closed-circuit television to read texts. He also uses a special keyboard. Another student who is unable to use his fingers types on a keyboard with the aid of sticks attached to his hands. As mentioned above, another student who has the use of only one hand uses a mouth stick to get over the problem of using the *control* key. The same student said that he had experienced difficulty in connecting his computer and modem and he had been forced to get someone else to help him with this. He therefore suggested that a built-in modem would be a help. This would also reduce the number of cables involved. Similarly he suggested that an auto-dialler would relieve the problems of people who are unable to dial a telephone themselves.

3.7 Summary

This section has reported the results of the telephone survey of selected students. Section 4 presents the results of a related survey which was aimed at a wider selection of students. These results are organized under the same headings as above and the overall findings are presented in Section 5.

4. Results of the questionnaire survey

The university's Office for Students with Disabilities regularly circulates students with a newsletter. The edition for October 1987 included an abridged version of the questionnaire used in the telephone interviews (see Appendix C). The significance of results of this survey is slightly

different from those of the telephone survey. For one thing, reducing the original questionnaire to a size and format suitable for publication in the newsletter meant that some information was lost. Secondly, the people included in the two surveys are very different. Whereas the students included in the telephone survey were deliberately selected, those covered by the second survey were drawn from the entire population of disabled OU students, and were essentially self-selected; they comprised only people who were sufficiently motivated to take the trouble to fill in and return the questionnaire. The responses suggest that for the most part people replied out of a genuine desire to be of assistance, but a small number appear to have been sent because the respondents were looking for specific assistance relating to the use of computers.

Seventeen replies were received, but one of the respondents had already been included in the telephone survey, so his responses to the questionnaire are not included here. The characteristics of the remaining (sixteen) respondents are summarized in Table 2. Another difference between this group and those covered by the telephone survey was that this one included nine people who use computers as study aids (mostly for word processing), of whom eight have not taken any Open University computing courses. It is also interesting that it was not only students who use computers (and therefore are interested in them) who bothered to reply; four students with no experience of using computers replied.

4.1 Choice of Courses

Out of the whole sample, just three students said that they would avoid taking a course which involved a home microcomputer because they anticipated difficulties. Of those three, one was a students who had not used computers at all before (student M). The second was one who had experienced severe academic problems with the computing element of D301[1].

4.2 Problems using equipment

Four students described problems which they had experienced in using computing equipment, due to their disability. One of them who has a visual disability mentioned difficulty reading small print. She also mentioned problems in typing, in using a shift key. Two others have

[1] D301, *Historical sources and the social scientist*, formerly included a computing element, based on the use of the university mainframe. However, because of problems experienced by students the computing component has now been removed from the course.

Subject	Nature of disability	Used a computer outside OU ?	Used a computer as a study aid ?	OU computing course(s)	Sex
A	Multiple sclerosis	no	word processing	none	M
B	Muscular dystophy	yes (unspecified)	word processing	M252, TM222	M
C	Coronory artery disease, angina	amateur radio, word processing, database[1]		none	M
D	Spinal condition, arthritic joints	trained in commercial use& word processing	no	none	M
E	Spinal injury, inability to sit for long periods	no	no	none	M
F	Cerebral palsy	yes (unspecified)	yes (unspecified)	D301	M
G	Partially sighted, arthritis	no	no	none	F
H	Spina bifida, visually disabled	word processing, set up database	word processing	none	F
I	Multiple sclerosis, chronic asthma	teaches word - processing	no	none	F
J	Tetraplegic	no	word processing	none	F
K	Brittle bones	yes (unspecified)	word processing	none	F
L	Multiple sclerosis	no	word processing	none	F
M	Multiple sclerosis	no	no	none	F
N	Stills disease	word processing	word processing	none	F
O	Cerebral palsy	in employment as civil servant	yes (unspecified)	none	M
P	Multiple sclerosis	no	no	none	F

[1] It is not clear whether this student used word processing and a database for his study or in connection with his hobby, or both.

Table 2. A brief description of the students surveyed by questionnaire.

problems in sitting for long periods at a computer. The fourth also has physical problems of posture. She uses a word processor but cannot move forward to manipulate discs in and out of the disc drive. She therefore has to use a "long gadget" to perform disc changes. Unfortunately she must perform such manipulations frequently since her computer has but one disc drive and small memory.

All four of the students who had experienced problems using their equipment because of their disability had received help from other people. Two others had also received such help, but did not specify from whom.

4.3 Equipment reliability

Of all the twelve students who use computer equipment, seven had experienced problems of their equipment breaking down. The greatest inconvenience seems to have been experienced by a student whose equipment has twice broken down during exams, one of them having to be retaken.

4.4 Finance

All but two of the students said that a decision regarding the taking of a Home Computing course would depend on whether adequate finance were available.

4.5 Documentation and training

The majority of students who have used computers thought that the documentation was inadequate. Nine of them expressed such mis-givings, while just four were content with the documentation. All but one of them thought an introductory training course would have been useful. Two of them said they had taken such a course outside the OU.

4.6 Special equipment

Four students use special equipment. The simplest example was a tetraplegic student who uses a splint with which to type. Two students use special devices in place of a keyboard. One uses a *Microwriter*, which is a six-key keypad which can be operated by one hand. Another uses an *Elfin* keyboard substitute which is operated by sucking and blowing on a pipe. The fourth student was mentioned above as using some kind of long grab to handle discs.

Two students mentioned that they did not need special equipment at the moment, but since their disabling condition is progressive they may need it in future.

5. Lessons to be learned

5.1 Support

Several students were seriously disadvantaged by the lack of technical support. This is very likely to become a more severe problem when students are using computers in their own homes. Isolation must always be a potential problem for distance learning students, one which is likely to be worse for those whose mobility is curtailed by a disability.

There are several levels of support required. The first one is in the provision of adapted equipment. The results of the telephone survey suggest that there may be students who have decided they will be unable to do a particular course because their disability affects their ability to use computer equipment. Yet, in most cases there may be suitable adaptations available. One example of this in the telephone survey was the student who had not taken computing courses because of her blindness. This problem is exacerbated by course descriptions which have a tendency to over-estimate the likely difficulties of disabled students. (See Open University, 1987b). An ideal would be to reverse the assumptions, so that the university might state that no student will be excluded from completing a course because of difficulties in accessing a home computer. (All ideals are hard to realize).

The field of information technology aids for disabled people is a rapidly changing one and it is not surprising that many potential consumers are not aware of the possibilities. That this is the case is confirmed by the equipment survey conducted by the Office for Students with Disabilities (Open University, 1987a). It is to be hoped that this will be much less likely to occur in future as the university is implementing a formalized procedure for assessing the information technology requirements of disabled students. This takes the form of a pilot project for 1988, to be undertaken by the National Federation of Access Centres. Through this project it should be that students will receive the best possible advice on what is available and will not have to cope so much on their own.

The majority of students included in the questionnaire survey were using computers as study aids. As would be expected, therefore, they seem to have been more aware of what is available. All the same, some of them would probably benefit from assistance in improving their equipment. An example would be the student who said she had difficulty reading small computer print, who might make use of a screen enlarger.

The requirement for this kind of support will *not* be short term. Student's needs will develop, as will the equipment available. Therefore students ought to be regularly monitored and provided with further support. That support may take the form of training, of provision of new equipment or of further adaptation and tuning of existing equipment.

The second level of support required is for students who have embarked on computing courses and then encounter problems. A number of people were identified in the survey who had had that kind of experience in the past. There was the student who did not know how to freeze the scrolling of text on a screen. Not only did he not know how to do this, he apparently did not even know it was possible. Furthermore, he did not know anywhere he could turn for help. That was an example of a technical problem which was never solved. Others were solved, but only with considerable effort. One example was the student who did his programming on his home computer and had to manually transfer data files from the university mainframe. Another was the student who was fortunate enough to have a friend with sufficient technical ability to adapt her hardware.

Good documentation and course material will be most valuable. Students in the questionnaire survey seem to have been less satisfied with their documentation. It must be said that as most of these students were *not* taking university computing courses they did not have study guides and so were reliant on manufacturers' documentation. Hopefully good quality course material on Home Computing courses will alleviate this sort of problem, but ultimately it will be necessary to have an effective telephone 'hot line' service available. This will, of course, have to be backed up by other maintenance services. There will also have to be a parallel service for those who cannot use the phone, particularly people with hearing disabilities. An electronic mail hot line would be a very good substitute. However, that too would have to be backed up by a postal mail service, since the very problem about which the student is trying to communicate may preclude them from using electronic mail!

Related to the need for good documentation is the possibility of training of students in the use of the computer. Indeed, one student made the point that training was required because "Reading through large books for quite small amounts of information is quite time-consuming." Every one of the students surveyed by questionnaire who had already used a computer said that they would have benefited from an introductory course. There is a question as to how feasible this might be, and how compatible with the methods of distance teaching. Students implied that what they wanted was face-to-face tuition, which is exactly what is most difficult for a distance teaching institution to provide.

There was no suggestion from the respondents that they felt they needed special tutoring because of their disabilities; they wanted the sort of training from which any computer novice might benefit. The university will be providing this for all students on Home Computing courses, in a distance teaching format. This should be sufficient to meet the needs of all students. So, although assistance with basic computer operation must be provided for all students, there is not a *strong* case for special, personal provision for students who are disabled. One exception to that would be in the case of students who use special or adapted equipment because of a disability. Clearly they might need personal training in the use of that equipment. Also there will be a need to have training material adapted to the needs of individuals. This occurs already with all OU course materials, such that, for example, printed texts are transferred to audio tapes for students who are visually disabled.

A number of specific suggestions were made in the survey about better equipment. For example, one student suggested that having a built-in modem and an auto-dialler would make it easier for some students to work independently. It is to be hoped that such specific, individual requirements will be covered by the National Federation of Access Centre's assessment procedure. This implies that it is not necessary to say that all students must have built-in modems and an auto-diallers (so increasing the cost of the basic equipment), but if an individual needs such equipment they will be identified and catered for.

5.2 Selection of courses

It is clear that access to courses on computing is a very valuable opportunity for many people who are disabled. Computing skills are valuable in the job market and can be acquired by many people despite their impairments. It is therefore imperative that the university devotes sufficient effort such that courses involving computers are made accessible to such people.

Home computing courses are therefore likely to attract a large number of students who are disabled. At the same time the fact that computing courses are moving into students' homes seems likely to appeal to more students who are disabled, particularly those whose mobility is restricted. It may be that there are a number of students in the same position as the one surveyed who said she automatically selected only courses which

could be studied entirely at home. Such people can now take computing courses.

Thirty-four of the thirty-nine students surveyed all together (telephone *and* questionnaire) said that potential problems of access to computers would not deflect them from taking a Home Computing course. Sixteen of the students had taken no OU computing courses. Of those, eleven were female. Furthermore, six had not used computers at all, five of whom were female. Other research has been done on the attitudes of women to computing courses (Kirkup, 1988 and Kirkwood, 1987), but it is worth questioning whether women who are disabled may represent a doubly-disadvantaged group.

5.3 Finance

A discussion of the economic position of disabled people could form the basis of a complete paper in itself. There are conflicts between the desire of all people to attain independence and the ability to earn sufficient money to be independent. One fact is that in general the earning power of people who are disabled is significantly less than average. At the same time, it is going to be more expensive to take Home Computing courses than other Open University courses if students have to buy the computer. (See Appendix A). Given the principle of open access, special financial arrangements must be available to people who wish to study with the university but who cannot afford to pay to do so. A number of those people will be disabled.

5.4 Problems

As described above, several students reported that they had experienced problems in the past, with the old teletype terminals. Since these are no longer used, this is no longer a problem. However, it does illustrate a valuable, more general lesson. The problem might have been avoided if the people selecting the equipment in the first place had thought about the likely problems of all the potential students on the courses. If the Home Computing Policy can be launched with an awareness of the special needs of some students right from inception, then many problems may be averted all together.

Typing was mentioned by several students as a source of problems. It should be borne in mind when developing course material that it should be designed such that slowness of typing is not made to be any more of a

disadvantage than necessary. This might be important if students are running some computer-assisted learning (CAL) software which measures response times, for instance. Such software must be capable of being re-configured to suit individuals. Two students mentioned another problem of manual dexterity, that of reloading a printer. Although this may seem a minor problem as an operation which is rarely required, it can nevertheless lead to a significant waste of time. It could also be psychologically significant to a student who can generally work independently, but needs help for this one operation. Hardware manufacturers seem to be singularly unable to design printers which are easy to load - even for people with a high degree of dexterity. However, it is a feature which should be borne in mind in the selection of hardware, especially for users with restricted dexterity.

6. Conclusions

It is a fact in our society that people who have disabilities generally have lower earning power than average. This means that most Open University students who are disabled would find it difficult to buy a home microcomputer. If the Home Computing policy is not to further handicap such students, therefore, it is imperative that alternative methods of finance must be made available to those who cannot afford to buy a computer. In fact, this applies equally whether they are disabled or on a low income for some other reason.

Assuming that suitable finance is available, the Home Computing policy is *not* going to disadvantage the majority of students who are disabled. For many it may indeed represent an improvement - in their educational prospects and study opportunities. The problems encountered by all students will generally be very similar: failure of hardware, difficulty understanding technical course material etc. In many cases the only difference for students who are disabled is that the effect of such problems may be more severe. Taking hardware problems, for example; a student who relies on her microcomputer on which she types all her written work is going to have her studies more seriously disrupted by a break-down than one who needs it only for the practical component of a course.

However, there is a (small) number of students who will be seriously handicapped because they have disabilities which make access to

computers difficult. In some cases they may be totally excluded from home computing courses. The university has a responsibility to support and aid these students as much as possible. This implies providing equipment and adaptations as required and supporting research and development of new adaptations where they are not currently available. It is also important that the needs of these students are taken into account as far as possible in the design of course material. (Recall that this will be the topic of a follow-up report to this one).

In many ways instituting a major new policy, such as the Home Computing policy, is a step into the unknown. The full effects of such a change are impossible to anticipate and people will have to learn as they go along. The work reported in this paper reduces the degree of uncertainty as far as the effects of the policy on disabled students is concerned. However, the survey reported was limited in scope, and this is unlikely to be the whole story.

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Appendix A

A summary of the Home Computing Policy

The Open University

Home Computing Policy

Information for undergraduate students intending to register for DT200, M205, M371 in 1988

Introduction

The University has been considering for some time the introduction of a policy which would move the practical computing component of certain Open University courses from the present, largely study centre based terminal facilities into the home. This is necessary because it is no longer practical to support the requirements of computer science and some other courses through study centre based facilities. 1988 will see the first major implementation of the policy, for the following courses:

DT200 *Introduction to information technology: technical and social issues*
M205 *Fundamentals of computing*
M371 *Computational mathematics*

In 1989 and beyond, further courses will come under the new policy, providing students with a range of courses from which to choose, and ensuring a good return on investment in the home computing facility.

Equipment specification

Students intending to register for DT200, M205, or M371 in 1988 will need to make their own arrangements to obtain access to a machine to the following (minimum) specification:

MSDOS (operating system)
GEM (Graphics Environment Manager)
512k RAM
single disc drive
keyboard (PC/AT)
monitor (monochrome)
parallel port (Centronics, for printer connection)
serial port (RS232 or equivalent)
mouse (or other pointing device)
printer (80 column, 100 cps)

This essentially defines a system based on an IBM PC.

Note

- 5.25" disc drives will be supported and consideration is currently being given to the support of 3.5" disc drives.
- Since a modem connection may be required for future courses, the serial port should preferably be separate from the mouse connector.
- For students who have access to a suitable machine but do not have GEM, the University will provide a means of acquiring the software at about £10 a copy.

In order to confirm that their equipment meets the above specification, students must ensure that the following software will run without modification:

UCSD PASCAL — will be used by M205
Lotus 1-2-3
PC Automator (Direct Technology) } will be used by DT200
Sidekick (Borland)

Access to a suitable home computer

Students will be responsible for ensuring that they have access to a suitable machine. The University will not be issuing the home computer for DT200, M205 and M371 as a home experiment kit, as has been done for certain courses in the past. The following arrangements have been made.

Purchase at a discount

The University has agreed with certain suppliers that students will be able to buy a machine which meets the above specification (including a printer and a mouse) at a discounted price which should not exceed £550 including VAT, and £430 for the same configuration without a printer. However, all three 1988 courses require students to have access to printed output, although for some students, use of one of the University's 100 back-up machines in certain study centres will be an acceptable means of printing the necessary material.

The University is negotiating with a commercial bank a personal loan scheme to help students with purchase.

Rental for one academic year

The University is being supported by the Department of Trade and Industry and the Department of Education and Science, which have provided funds for the acquisition of a stock of suitable machines for rental by students who do not wish to buy a machine. The cost of rental in 1988 will be about £150. For undergraduate students this means that the net cost of rental for a full-credit course will not exceed £100 (that is, rental fee less fee reduction, see below).

Other equipment

Students who already own or have suitable access to a machine which meets the required specification will also be able to register for DT200, M205 and M371 in 1988.

Fee reduction

For the first three years, 1988–1990, all courses in the undergraduate programme included in the new policy will be subject to a fee reduction. In 1988 this will be between £50 and £60 for a full-credit course and between £25 and £30 for a half-credit. The level of the reduction will be such that the net cost for an undergraduate student of renting a machine in 1988 will not exceed £100 for a full-credit course.

Back-up

A back-up of 100 machines will be installed, mainly in study centres.

Further information

In early August, full details of the discount purchase and rental options for 1988 will be sent to students conditionally registered for DT200, M205 and M371. This will include:

- Confirmation of costs and procedures for rental and purchase.
- An initial list of acceptable equipment.
- Details of personal loan schemes (if available).
- General timescales.

Do not buy a machine until you receive this further information.

Please note that the list of acceptable equipment will not necessarily be a definitive list, as we are unable to test all potentially suitable hardware.

Any special discounts available to Open University students will be included, as will the costs of upgrading the equipment, where the details are known.

In the short term the Academic Computing Service may be able to provide additional information in response to specific *written* requests. Enquiries should be addressed to: Academic Computing Service, Open University, Walton Hall, Milton Keynes, MK7 6AA.

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Appendix B

The questionnaire used in the survey

Questionnaire

All replies will be treated as confidential. Your name will not be used in any publications.

Thank you for taking the time to fill in this questionnaire. Many of the questions can be answered by putting a tick in the box next to the appropriate answer. In some cases you may want to tick more than one box in any one question (for example you may have taken more than one of the courses listed in question 2). If you tick certain of the boxes, you are asked for further details which you can write in in the space provided. Ticking some boxes means that some of the other questions do not apply to you, so you are then asked to skip to another question, otherwise just move to the next question.

If there is not enough space on this form for your answers, or you want to mention anything not covered by the questions, please feel free to add further comments.

Completed forms should be sent in the envelope provided to:

Dr Alistair Edwards
Institute of Educational Technology
Open University
Walton Hall
Milton Keynes
MK7 6AA

1. Have you taken any Open University courses which have involved the use of computers ?

Yes ☐

No ☐ *Please go to question 12*

2. Which course or courses were they:

D309	Cognitive psychology	☐
EH221	Educational computing	☐
M352	Computer-based information systems	☐
M353	Programming & programming languages	☐
SD286	Biology, brain and behaviour	☐
TM222	The digital computer	☐
Other		☐

Please specify which other(s):

3. Did you have any problems using the computer, caused by your disability?

Yes ☐

No ☐ *Please goto question 5*

4. How did you overcome these problems?

Help from other people ☐

Please explain what sort of help you received:

Using special equipment ☐

Please describe the equipment:

Avoiding doing optional computer-based parts of the course ☐

(continued...)

(...4 continued)

The problems were never satisfactorily overcome. ☐
Please explain:

Some other means ☐
Please explain:

5. Did you feel that you were at a disadvantage compared to other students in the computer-based work?

Yes ☐
In what way did you feel disadvantaged?

No ☐

6. Do you think you would have benefitted from an introductory course in the use of computers before you started any OU courses which use them?

Yes ☐
Which topics would you have liked covered?

No ☐

7. Did you have any reliability problems with the equipment i.e. breakdowns?

Yes ☐

No ☐ *Please go to question 11*

8. What were the problems?

9. How well were they sorted out?

10. Who sorted them out?

11. Did you find the Students' Guide and any manuals helpful?

Yes ☐

Which parts were particularly helpful?

No ☐

How might they have been improved?

12. Have you deliberately chosen to take courses which involved the use of computers or have you avoided them?

Avoided them ☐

Chosen to take them ☐ *Please go to question 15.*

13. What problems did you anticipate with using computers, to make you avoid computer courses?

14. Are there any Open University courses you would like to have taken, but did not do so because they involved the use of computers?

Yes ☐

Which course or courses?

No ☐

15. Have you had experience of using computers outside the Open University?

Yes ☐

Please describe how you have used them:

No ☐

16. Would you take a course in which the use of a home microcomputer was a major and compulsory part of the course?

Possibly ☐

Yes ☐ *Please go to question 18*

No ☐ *Please go to question 18*

17. Taking home computing courses would depend upon:

The availability of special equipment ☐
Please specify what equipment:

Adequate financial assistance ☐

The availability of modified course material ☐
What kind of material?

How badly you wanted to do that course ☐

Other factors ☐
Please explain:

18. Have you any other suggestions as to how your access to the computer-based material might have been improved?

Use the space below for further comments, if you wish:

Appendix C

The questionnaire distributed in the newsletter for students with disabilities

QUESTIONNAIRE ON THE USE OF HOME COMPUTERS

For Dr Alistair Edwards, IET

Name and personal identifier.....

Disability.....

1] FAMILIARITY WITH COMPUTERS

Have you already used a computer outside OU studies?.....

Have you already used a computer for your OU studies?.....

Have you already taken an OU course involving the use of a computer?.....

You have no experience of using a computer?.....
Please go to question 4.

Please give details of how you have used a computer.

.....

2] YOUR EXPERIENCE OF USING A COMPUTER

Did you find the manual / user guide adequate?.....

Did you have any equipment breakdowns or similar problems?.....

Would you have benefitted from an introductory course?.....

Please give details.

.....

3] USING A COMPUTER AND YOUR DISABILITY

Did you have any problems caused by your disability?.....
Please give details.

Did you have help from other people?.....

Have you found special equipment helpful?.....

Please give details.

Any suggestions for how you could be helped further?

.....

4] OU COURSES USING A HOME MICROCOMPUTER

Would you avoid a course using a home microcomputer because you anticipated difficulties?

.....

Taking a home computing course would depend on;

How interested you were in the course?.....

Adequate financial assistance?.....

The availability of special equipment or help?.....
Please give details.

The availability of modified course material?.....
Please give details.

Other factors.

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Thankyou for your assistance. All information will treated in confidence.

Please return to Dr Alistair Edwards, IET, The Open University, Walton Hall.

CENTRE FOR INFORMATION TECHNLOGY IN EDUCATION

List of CITE Reports

These reports may be obtained from:

Hansa Solanki, Institute of Educational Technology, The Open University, Walton Hall, MILTON KEYNES, MK7 6AA, England.

Report No.	Title and Author
1	A.T. Vincent, (1985) Computing and the Blind.
2	A. Jones, G. Kirkup, J. Morrison (1985) A Trial of Home Based Computer Terminals.
3	Gill Kirkup, (1985) The Present and Potential Use of Ceefax in the Open University.
4	Mark Elsom-Cook, (1986) Artificial Intelligence and Computer Assisted Instruction.
5	Mark Elsom-Cook, (1986) A Pascal program checker.
6	Simon Holland, (1986) How computers are used in the teaching of music and speculations about how Artificial Intelligence could be applied to radically improve the learning of composition skills.
7	Simon Holland, (1986) Design consideration for a human-computer interface using 12-tone three-dimensional harmony space to aid novices to learn aspects of harmony and composition.
8	Alison Petrie-Brown, (1987) The Influence of Context and Coherence as a Foundation for Dialogue Research.
9	Eileen Scanlon, Randall B. Smith (1987) A Rational Reconstruction of a Bubble Chamber Simulation Using The Alternate Reality Kit.
10	Mark Elsom-Cook, (1987) Intelligent Computer-Aided Instruction research at the Open University.
11	Mark Elsom-Cook, (1987) Towards a framework for human-computer discourse.
12	Mark Elsom-Cook, (1987) MATILDA AND IMPART: Lisp tools.
13	Mark Elsom-Cook, (1987) Guided discovery tutoring and bounded user modelling in Intelligent Computer Aided Instruction ed. J. Self, Chapman-Hall 1987.
14	A.M. Petrie-Brown and M.T. Elsom-Cook, (1987) An Examination of an AI model of indirect speech acts.
15	A. Edwards, (1987) Integrating Synthetic Speech With Other Auditory Cues In Graphical Computer Programs For Blind Users.
16	S. Holland, (June 1987) A knowledge-based tutor for music composition.

17 S. Holland, (June 1987) New Cognitive Theories of Harmony Applied To Direct Manipulation Tools for Novices.

18 M. Baker. (July 1987) Intelligent Computer-Aided Instruction and Musical Performance Skills.

19 M. Baker, (August 1987) Proposed Research Directions for Intelligent Computer-aided Instruction in Musical Performance Skills.

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26 P. Fung, (November 1987) Novice Prolog Programmers.

27 P. Fung, B. DuBoulay & M. Elsom-Cook, (November 1987), An initial taxonomy of novices' misconceptions of the Prolog interpreter.

28 G. Kirkup, (November 1987), Considering the effect on women students of an increased use of microcomputers in distance education.

29 Sara Hennessy, Rick Evertsz, Dave Ellis, Phil Black, Tim O'Shea Ann Floyd, Design Specification for 'Shopping on Mars' a computer-based Educational Acitivity.

30 A D N Edwards, The use of home computers by disabled students at the Open University. Part 1: Previous use of computers in courses